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Quantifying groundwater/surface-water interactions in small tributary drainages to the Wabash River using radon-222 and other environmental tracers

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Abstract

Groundwater/surface-water interactions have not been extensively studied in tile-drained watersheds where natural recharge processes are “short circuited” by routing water out of the soil-zone and into nearby drainage ditches. This practice likely impacts baseflow generation in the Wabash River of Indiana. If true, then how is baseflow affected in small tributaries to the Wabash? To answer this question, we investigated groundwater/surface-water interactions in four small tributary drainages to the Wabash River and Sugar Creek. These drainages share common geologic characteristics and are deeply incised providing a window into groundwater flow processes. We sampled these drainages for general geochemistry, radon-222 (^{222}Rn), tritium (^{3}H), and chlorofluorocarbons (CFCs). In addition, a simple experiment was conducted to quantify the ^{222}Rn production rates in native rocks (till, sandstone, and shale). The ^{222}Rn concentration of springs ranged from 163 (+/- 39) to 605 (+/- 72) pCi/L. In comparison, the ^{222}Rn concentrations in the streams ranged from 7.9 (+/-0.7) to 61.1 (+/-2.1) pCi/L indicating strong interactions with groundwater. The results from the ^{222}Rn production experiment indicate that the observed in-stream ^{222}Rn concentrations are larger than what would be expected solely by flow through the soil (a proxy for tile drainage). Tritium and CFC data indicate that mean residence times of springs range from 18 to 30 years. Field observations indicate that baseflow in these drainages is dependent upon groundwater from bedding-parallel fractures in the underlying shale. These data indicate that groundwater flow from an unlikely source, shale bedrock, is vital to baseflow generation in these small drainages.